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Appendix

1.0 Details of the energy savings obtained from improving Duct systems

In order to estimate the value of improved duct systems to utilities and their customers, it is necessary to have some estimates of the effects of improving duct systems on energy consumption, both for annual energy use and during hours of peak system demand. In this section we summarize the results of another research project concerning those savings.

Modera and Jansky (1994) estimate the energy and economic savings obtained from sealing and insulating duct systems. Their estimates are derived from computer simulations of HVAC energy use in model houses. They performed simulations for 6 cities in California and estimated energy savings relative to a base case which is described in Table 1. The base case was chosen to be typical of houses in California. The duct system in the base case is uniformly insulated to R-0.70 m^2·K/W (4 hr·ft2·°F/Btu), including the plenums. The return ducts, return plenum, supply plenum, and supply ducts have leakage areas of 39, 39, 10, and 59 cm^2, respectively, for the base case.

TABLE 1. Characteristics of the house used in Modera and Jansky (1994) to estimate typical savings from improvements to duct systems.

Quantity	Value
Construction	single-story ranch
foundation	crawlspace
floor area	144 m^2 (1540 ft^2)
insulation	California pre-Title 24
floor and wall U-value	uninsulated
Ceiling U-value	0.52 W/m^2/°C (0.092 Btu/h/ft^2/°F)
windows	standard single-pane
total nominal heating capacity	23.4 kW (80,000 Btu/h)
nominal efficiency of gas furnace	0.8
total nominal cooling capacity	11.7 kW (40,000 Btu/h)
nominal compressor COP	2.93
fan flow	1700 m^3/h (1000 cfm)

Table 2 contains Modera and Jansky's estimates of the annual dollar savings in energy bills for various duct system improvements. What is of interest to the creation of a new system of snap-together leakproof fittings are the savings which result from decreasing leakage. Decreasing all leakage by 50% was seen to give savings between $16 and $43. Sealing 90% of the leakage gives annual savings of $40-$100.

TABLE 2. Estimates for the savings to the home owner and utility arising from having tighter and more insulated ducts. The conservation load factor is the ratio of the percentage increase in duct efficiency at peak to the average percentage increase in duct efficiency. Taken from Modera and Jansky (1994).

improvement	annual savings		conservation load factor[a]	reduction in peak electrical demand per house (kW)
	total $	$/m^2 of insulation		
insulting plenums and ducts from R-4 to R-8	$14-$51	$0.22-$0.82	2.2-3.9	0.4-0.8
50% reduction in leakage	$16-$43	n/a	1.5-4.3	0.3-0.8
90% reduction in duct leakage	$40-$100	n/a	1.4-2.7	0.7-1.5

[a]The ratio of % change in duct efficiency at peak with the improvement to % change in average duct efficiency.

For utilities, the effects of duct improvements on air conditioning electrical draw during periods of peak demand are of even more interest. Table 2 contains estimates of peak electrical demand reduction, however these are best case estimates. It is assumed that the air conditioning system is currently meeting the cooling load. If it isn't, then the customer will take back some of the energy savings in improved comfort. It is also assumed the air conditioner is replaced by a lower capacity unit when the duct system is improved. However, the reductions in peak power shown are very significant and range from 0.4 kW to 1.5 kW. On a percentage basis, these savings are

2.0 Details of the cost estimates for other possible improvements to duct systems

Tables 3 and 4 give details of the estimated costs for other methods for improving duct systems.

TABLE 3. Details of the estimated costs, relative to current practices, for increasing duct insulation to R-8 or sealing ducts before finish work is complete.

Improvement			contractor cost relative to current practices[a]	comment
increasing duct instulation from R-4 to R-8		labor	$0	since the insulation is incorporated into the duct, there are no additional labor costs
		materials	$100	
sealing ducts before finish work is com-plete	50% sealed	labor	$40-$100	Modera (1992) estimates a single worker could seal 2-5 houses a day.
		materials	$0	the contractor already uses mastic and/or duct tape
	75% sealed	labor	$80-200	Assumes that the 50% sealing could be repeated in the same time. i.e. the 50% leakage could be reduced to 25% leakage.
		materials	$0	

[a]Labor costs are assumed to be $25/hr. See Kiley and Moselle (1995).

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TABLE 4. Details of the cost estimate for placing ducts in the conditioned space.

Item		contractor cost relative to current practices[a] labor	materials	total	comment
multiple story house		$600	-$600[b]	$0	This assumes sheet metal ducts, which are less expensive but harder to install, are used. If flexduct is used, both material and labor costs remain basically unchanged. It also assumes that an open joist structure is used between floors and this allows space for the ducts.
single story house	second ceiling in hallway	$300	$400		Assumes ducts are run above a 2nd ceiling in the hallway
	taller hallway walls	$100	$100		In order to maintain ceiling height in the halls, the top ceiling has to be placed higher
	other	$50	$50		To allow for other difficulties.
	ductwork	$600	-$600		same as for multiple story houses
	total	$1050	$-50	$1000	

[a]Labor and material costs are from Kiley and Moselle (1995) except where noted otherwise.

[b]Kiley and Moselle (1995) estimate $700 for an 8 register system. Adding up costs from sources, we estimate $500. Allowing for excess, which Kiley and Moselle do, $600 seems a reasonable estimate

3.0 Other potential designs for plenum fittings

Two potential designs are for plenum fittings are shown in Figures 1 and 2.

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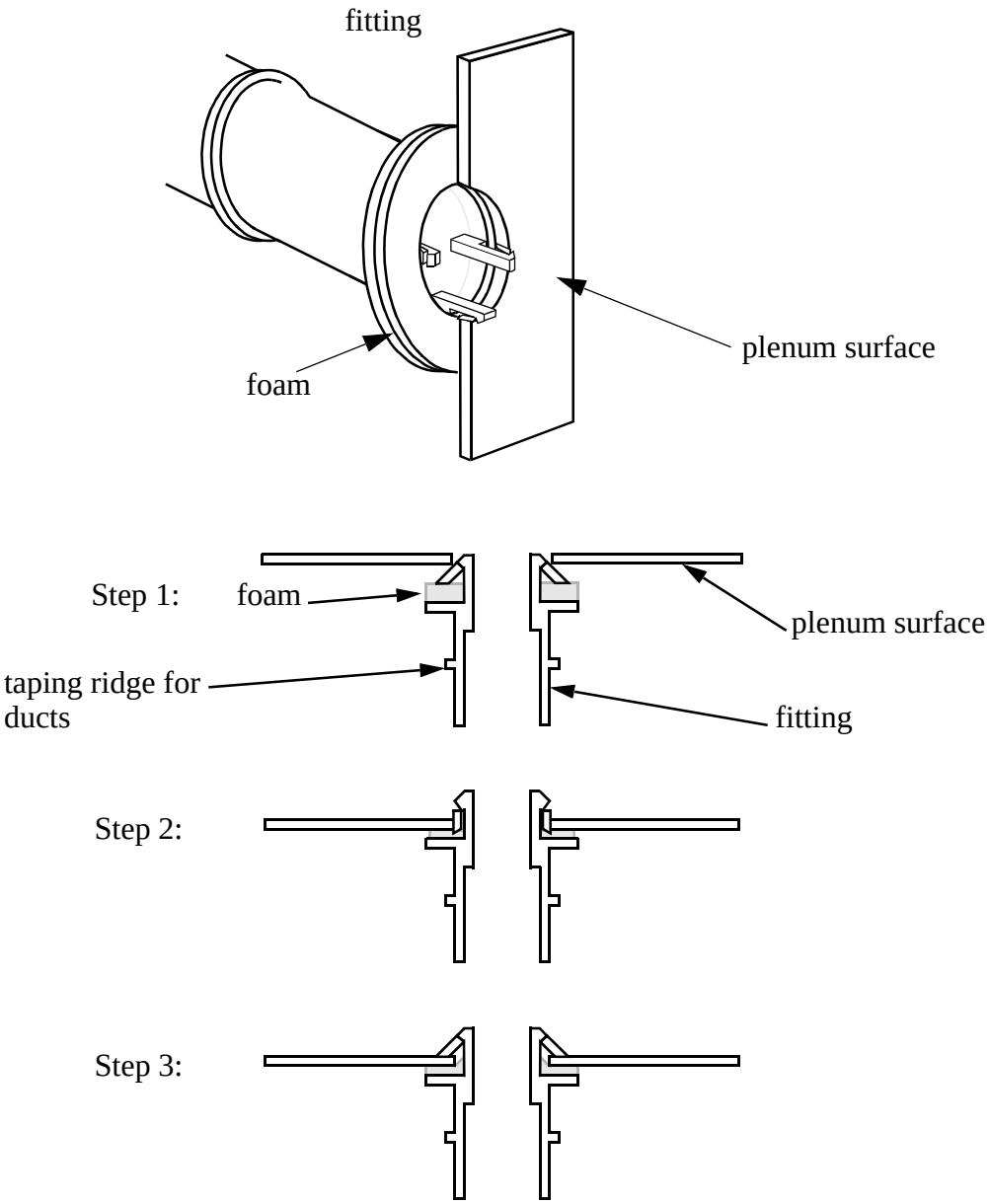

FIGURE 1. Schematic design of a fitting to attach to a plenum. This design snaps into place and is self-sealing.

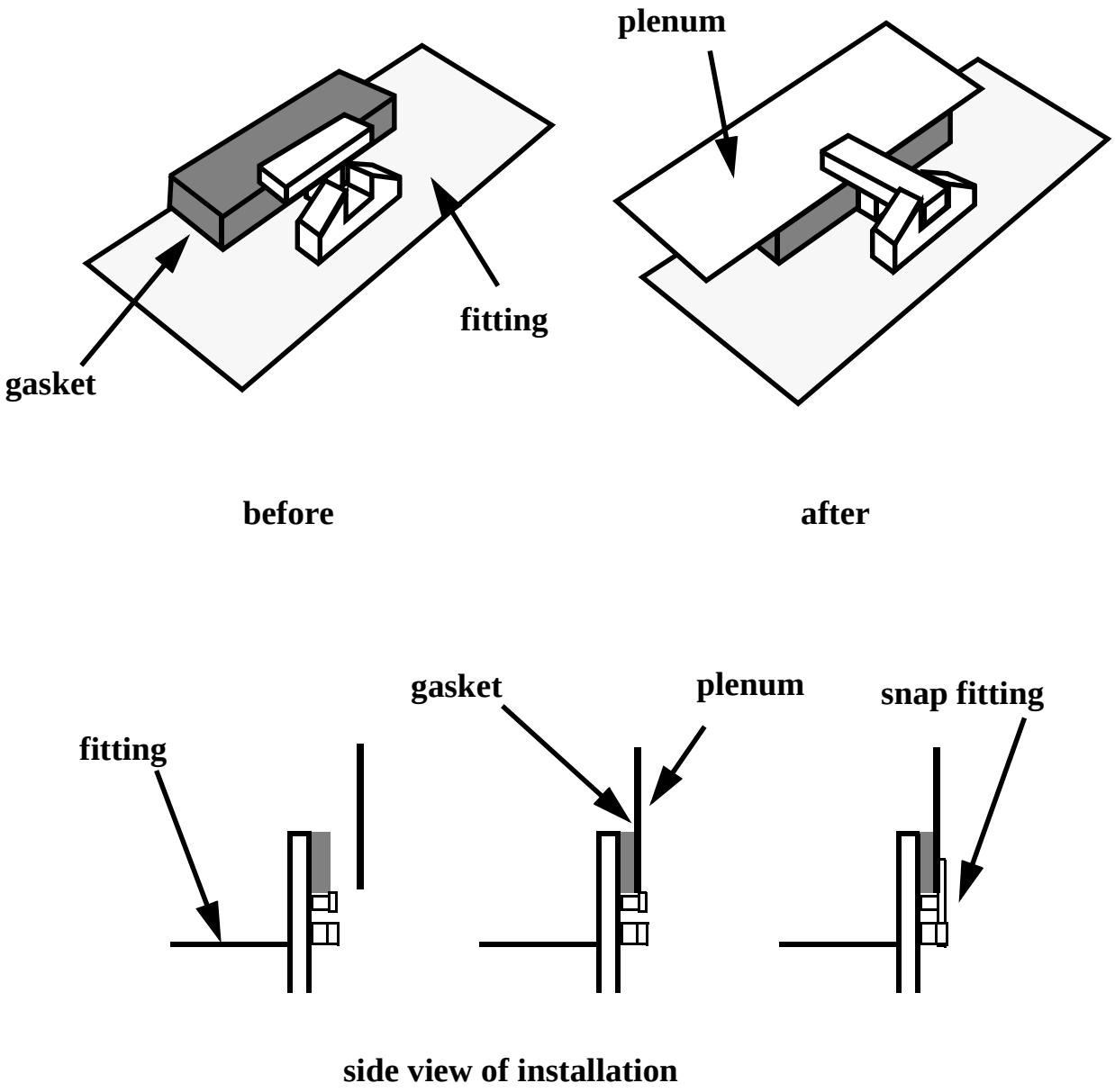

FIGURE 2. Second possible plenum connection. This design installs easily and is self-sealing.